Center for Advanced Computation

UNIVERSITY OF ILLINOIS AT URBANA-CHAMPAIGN
URBANA ILLINOIS 61801

THE COAL FUTURE

APPENDIX D

Reserve and Resource Estimation

Appendix D

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The Coal Future: Economic and Technological Analysis of Initiatives and Innovations to Secure Fuel Supply Independence

by

Michael Rieber
Center for Advanced Computation
University of Illinois at Urbana-Champaign

and

Shao Lee Soo
James Stukel
College of Engineering
University of Illinois at Urbana-Champaign

Advisor
Jack Simon, Chief
Illinois State Geological Survey

Center for Advanced Computation
University of Illinois at Urbana-Champaign
Urbana, Illinois 61801

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APPENDIX D

Reserve and Resource Estimation

Contents:

COAL RESERVE ESTIMATION

Resources include all coals in the ground which can reasonably be assumed to exist and which are estimated geologically or statistically. Reserves relate to coal in the ground classified according to the degree of reliability of the data, to the depth of burial and to the thickness of the seam (implicit in this may be the mining method required for removal). Physical reserves are significant as indicating those minerals which may be developed in the future, but should be distinguished from deposits proven to exist which can be mined with existing technology under current economic conditions (economically recoverable reserves). The application of standard recovery factors to reserves is inconsistent with reserve estimation as these do not sufficiently discriminate among coals and among habitats. Furthermore, all assumptions concerning equipment capacity, reserves, etc., should be clearly stated to facilitate recalculation of reserves if any parameter(s) changes at a later date.

Because of air pollution control, economically recoverable reserves should be further subdivided into sulfur categories based on total sulfur, sulfur types (organic and inorganic), and percent washability. Furthermore, provision should be made for classification by sulfur category on a comparable Btu basis.

Strippable reserves should be reported as both the percent and amount strippable. These reserves are currently part of economically recoverable reserves, but may have to be recategorized in the light of anti-strip mine legislation.

The end result of a classification should be the ability to derive from the data any segment of information required for policy, e.g., a report of low sulfur economically recoverable reserves by seam, county, seam thickness, depth and thickness of overburden.

The U.S. Bureau of Mines' data file has at least one inherent failing because it uses data from surface exposures, such as operating and abandoned mines, and extrapolates using varying degrees of geologic inference. This method results in an overall crude estimate of physical reserves suitable for mine use but not sufficiently accurate for an assessment of energy resourcs and optimization of their use. The coal Resource-Reserve Criteria used by the U.S. Bureau of Mines (USBM) for classifying coals by rank closely follows the depth and thickness categories used by the U.S. Geological Survey (USGS), making the use of USGS publications fairly easy. The criteria delineate five resource categories including total and undiscovered resources (the least specific); identified resources, subdivided into measured, indicated and inferred resources according to degree of geologic assurance (reliability); and the reserve base, which includes some beds that are thinner or deeper than general criteria permit, but are currently being mined or could be mined commercially at this time. This last calls into question their entire scheme of resource classification. Thinner coal seams in all categories are considered subeconomic resources. Reserves are then defined in the same way as the reserve base by applying general recoverability factors but with no explanation of how the factors are derived.

Other elements which reduce the utility of the USBM data bank as a catalogue of resources and reserves include:

1. Thickness limits within a category are economically controlled and should be reduced uniformly to conform with state data sources in order to be inclusive of all measurable reserves.

2. Classification of reserves by the reliability of the data should differentiate between data based entirely on surface exposures, mining operations and their extrapolation; and those based also on reliable subsurface data. The former may be subject to review should legislation curtail or eliminate surface mining operations or should changing economics (technology) lengthen mine life. The latter is the only reliable measure of reserves that accounts for coal seam variability.

Heretofore, the emphasis in reserve estimation has been on net available reserves and in situ resources because they are related to the investment in the mine. National priorities require that the emphasis be shifted toward realistic estimations of overburden and mineable reserves in proposed and working mines, and toward additional geological work in a number of states to provide reliable information on strippable reserves as well as in situ reserves. Accurate reserve estimation of coal available for mining is a requisite for good mine planning but it is also necessary for mine owners to be aware of their in situ reserves as strippable and underground reserves may be subject to new developments such as in-place gasification, altered demand, e.g., for lower rank coals for gasificiation, as well as changes in conventional mining techniques. Presently, reserve estimation in a working mine is required only for: 1) determination and corroboration of the amount of excavation of coal and overburden; 2) for future planning; 3) for quality control; and 4) for technical auditing and control of mining operations.

The basic schematic differences proposed here, compared to that used by the USBM, are not simply conceptual but involve correcting discrepancies between the stated and effective utility of the methods used. The USBM categories are complicated, overlapping, unrelated to costs and not functional with respect to national priorities. Their emphasis is not upon estimating economically recoverable reserves but physical reserves and resources.

Additionally, it is not at all clear how the data bank provides their estimate of reserves. The application of recovery factors used in the derivation of the reserve base is inconsistent with reserve estimation and is perhaps only significant in individual mines.

For national policy purposes, the aim should be a data base categorized in such a way that movement between categories is only with respect to new geologic data. The subdivision of reserves into physical and economically recoverable categories would be based on current, state of the art, mining technology with respect to the geologic structures and habitat and with respect to coal prices. As in the petroleum industry, this would allow for shifts in recovery factors if, for example, secondary recovery becomes profitable or new techniques remove a greater percentage of coal from the ground or out of preparation plants. Furthermore, on an economic basis, more attention could be paid to coal quality: Btu content, sulfur content, ash, moisture, etc.

Illinois and Wyoming have been investigated as examples of states whose approach to coal reserve estimation provides some signficant contrast. The differences are in part geological; e.g., the nature and occurrence of the coals; and, in part, economic. To date, it has not been necessary or profitable for Wyoming geologists to prove and measure reserves outside of presently working mines. In view of the low sulfur content and vast resources potentially available, it would be advantageous to have an accurate, consistently derived, physical and economically recoverable reserve estimate for Wyoming. Illinois coal estimates on the other hand, may be considered nearly all reserves rather than a reserve-resource mixture.

A. Illinois

Illinois' coals are all mined from Pennsylvanian strata which extend to depths of about 2,000 feet in the Illinois basin. The lower (approx.) 600 feet in the deepest parts of the basin in Cumberland, Richland and Clay Counties, is sandstone that is either non-coal bearing or that which contains only small splits of coal. Thus, Illinois coal reserves have been mapped where they exist to a maximum of 1,500 feet. In Illinois, underground coal mines extend only to depths of 800 feet.

The latest estimates of coal in the ground (physical reserves) for Illinois were published in January 1974, by the Illinois State Geological Survey. The new estimate of 148,172,540,000 tons includes estimates of coal thicknesses for parts of the Illinois basin derived from electric logs.[1]

Changing technology and economic conditions determine how thick a coal must be to be considered commerically mineable at any given time. These factors vary in different parts of the State. Two factors directly affect the mine price in Illinois strip and underground mines, the depth of overburden and the thickness of the seam.

In Illinois only oil pool areas, heavily drilled for oil and gas, have been excluded from the reserve estimates. In the classic study of coal reserves in Illinois(2) the evaluation of mineability was based entirely upon the criterion of thickness, but it is generally conceded that surface features such as cities, towns, highways, railroads, etc., render coal unavailable for underground mining. To assume, however, that thickness is the only criteria determining mineability results in too large an estimate of recoverable coal. Several other factors such as mining method and economic factors are involved. The estimates include coals that are greater than 28 inches in thickness, if more than 150 feet deep, and greater than 18 inches if less than 150 feet deep. Thinner coal seams are not included in the estimates.(3) An estimate of 1,800 tons per acre foot of coal was used in calculating Illinois reserves. Though in some areas, 1,770 tons per acre foot is probably more representative of Illinois coals.(4)

In Illinois, the thickness limits used by the State Geological Survey are sufficient to cover all the reserves (as defined) because relatively little coal as thin as 18 inches has been mined. Further, although it is technologically possible, very little strip mining has as yet moved more than 100 feet of overburden. Some coal seams approximately 30 inches thick have been mined in small operations. Most sizeable operations mine coals three to four feet thick, and, in large scale operations, the coal seams are generally even thicker. Currently no underground coal seams less than four feet thick are being mined.[5] Therefore, there is an unspecified tonnage of coal, currently outside the measured limits, not included in the reserve/resource estimates.

An important aspect of Illinois coal reserve data supplied by the Illinois State Geological Survey is the detail presented. The estimates would increase if the thickness limits were lowered, but they would not be altered as significantly by the elimination of strip mining as in those states where the entire measured reserves are in areas of surface exposure, in outcrop, or in operating or abandoned mines, e.g., Wyoming.

The categories of reserves of Illinois coal consist of I-A, proved reserves; I-B, probable reserves; II-A, strongly indicated reserves; and II-B, weakly indicated reserves. The last two are actually resource estimates, the first two are physical reserve estimates.

I-A reserve areas are defined as extending no more than one-half mile from a mined out area, diamond drill hole, or an outcrop. This distance is arbitrarily chosen but it is that which was found best suited to the nature of Illinois coals. In view of the better knowledge of the occurrence and extension of Illinois coals, the limit of proved coal could be extended somewhat farther than is suitable for the country as a whole. The results of drilling indicate that the customary one mile spacing of drill holes (1/2 mile extension) provides sufficient control of the estimated quantity of proved coal, even in areas of structural or sedimentary irregularity. This category is approximately equivalent to the "measured" category of the USGS.

Class I-B, probable reserves, are generally defined as not extending more than two miles from a mined out area, outcrop, diamond drill hole, or churn drill hole known to have been drilled as a coal test. This classification is essentially equivalent to the USGS category of indicated reserves. This amount represents about 12.5 square miles around the drill hole minus 0.81 square miles of proven reserves if it is a diamond drill hole. This category provides reserve estimates where dependable information plus geological interpretation strongly indicates the presence of a coal bed equal to or greater than 28 inches thick and justifies drilling to "prove" the area.

Strongly indicated reserves (II-A) and weakly indicated reserves (II-B) are, together, approximately equivalent to the inferred category of the USGS. The maximum extent of the former is four miles; and the latter, indefinite. Geological information is more important in these two categories because of the lack of direct evidence. Such information includes lateral persistence of workable thickness, channeling relationships, structural features, etc. The resources in these two categories can scarcely be regarded as reserves because they await development without additional exploration yet they must be accounted for in the evaluation of the coal resources of the state.

The data used as a basis for mapping the extent of coal resources in category II-A consists of drill holes, mines, outcrops, churn drill coal test holes, churn drill holes drilled for oil, gas, or water (with sufficient records), and "control" rotary drill holes (logged). However, these data supplied by the well logs commonly do not provide adequate information upon which to judge the quality of roof rock. The information about the coals in "control" rotary drill holes are fairly reliable. Their logs have been used as a basis for outlining areas of II-A "reserves" for all of the No. 5 and No. 6 coals, particularly in the deep areas of the Illinois basin where there has been almost no diamond drill exploration for coal. Electric logs may strongly suggest the presence of coal. They give only approximate thicknesses and so they have not been used to delineate areas of this or higher classes of reserves.

In class II-A, recorded thickness were used as a basis for estimating thickness by township. These estimates are of dubious value. The estimates in this category will change with any new information.

Class II-B, weakly indicated reserves, is highly subject to arbitrary evaluation. These are reserves for which none of the more reliable data were available. They are based on the geological probability that suggests that a coal seam of at least 28 inches (or more) is present. The status of such areas changes with increased drill holes and logging.

All coal beneath 1,200 feet was put in Class II-B except such coals as were penetrated by diamond drills. In this case, they are still not extended beyond one-half mile of the drill hole. This limit applies only to beds below the No. 6 coal which, to date, are not considered commercially important at that depth.

In Illinois a few areas remain for which sufficient information for reserve estimation is not available (e.g., the Pennsylvanian (age) boundary in western Illinois) yet the Illinois' estimates are probably the best there are and, at best, are probably still conservative. The amount of mineable coal in the Illinois basin is much reduced by close drilling for oil. In the process of extension of the known resource area in southeastern Illinois, the interpretation of coal thickness had to be obtained from conventional electric logs which show reasonably accurate estimations, particularly where the coal is overlain by at least a few feet of grey shale. Some such lithologic control is necessary for correct thickness determination and interpretation in these cases. The logs are of oil tests in large tracts which have never been explored for coal primarily because adequate reserves were available in shallower areas. Resistivity curves delineate the thickness of rock units and determine the amount and character of contained fluids. Thicknesses so determined have to be regarded as estimates though, when the determinations by this method are checked against nearby diamond drill holes, agreement between the two sources of information is good and within the value of normal variability. No determinations of thicknesses less than three feet were attempted from electric logs.(6)

In Illinois about 14 percent of the total coal reserves is found in seams less than 150 feet deep, much of which can be stripped economically with present equipment.(7) Stripping coal reserves are divided into primary and secondary reserves to designate the reliability of the estimate. Primary reserves are equivalent to I-A, proved reserves, and I-B, probable reserves. Secondary reserves include classes II-A and II-B, strongly and weakly indicated reserves, respectively.

The evaluation of strippable reserves is based principally on thickness of coal and of overburden. Strippable coal reserves include coal seams greater than or equal to 18 inches in thickness (averaging approximately 24 inches) and have an overburden of less than or equal to 150 feet. In this estimate non-recoverable coal is not excluded from the estimates which are based on total coal in place. Strippable reserves are further divided into three categories: 0-50 feet, 50-100 feet, and 100-150 feet; although 100 feet of overburden represents the approximate maximum limit of strip mining to date.[8]

Compilation of tables based on overburden categories are impracticable for some parts of the State as coal seams thin and thicken abruptly and can only be mapped in areas adjacent to surface exposures, abandoned mines, etc. In this case, an overall gross estimate of reserves has been made on the basis of a large number of records within a small area for the most reliable estimate of coal reserves. These reserve estimates are confined to Class I, primary reserves, because of the limited projectability of the coal data.[9]

The preferred basis for evaluation of coal is the heat value of the pure carbon excluding moisture, ash, and mineral matter. This measure has been called the "unit coal heat value" and has been determined for a group of representative Illinois coals by mine, county and bed. A modification of the value called the moist mineral-matter-free Btu basis has been selected as the basis for rank determination by ASTM for the high volatile bituminous coals of Illinois containing less than 69 percent fixed carbon (on the dry mineral-matter-free basis), greater than 11,000 Btu (on the moist mineral-matter-free basis) and either agglomerating or non-weathering.

Rank has some advantage over unit Btu value as an index of coal material if a satisfactory representative value for moisture of the coal can be obtained. In Illinois, rank is fairly consistent within individual counties and increases systematically from the northwestern to southeastern part of the State.[10]

Even when the data are good, gross discrepancies among reported estimates made by different organizations may occur. This is exemplified by a county by county comparison between estimates made by the Illinois State Geological Survey and the U.S. Bureau of Mines' estimates of the bituminous coal reserves of Illinois. According to the Survey, underground coal reserves are approximately 122,041.8 million tons. According to the Bureau of Mines they are only 53,441.9 million tons. As estimated by the Bureau of Mines (IC8655), the underground coal reserve base does not include tonnages for coals less than 28 inches thick and at depths greater than 1,000 feet. Those beds considered too deep, too thin, or in which the tonnages are in an inferred category (strongly or weakly indicated reserves of ISGS) are not included in their estimates. Entire counties were omitted because the coals are strippable, too thin, too deep or inferred. Their estimates therefore exclude coals included in the ISGS estimates between 24-28 inches and depths greater than 1,000 feet, but these few exceptions do not account for the large discrepancies between the estimates derived from the available data. Much more may be due to the inclusion, in the ISGS data, of coal which may not be mined due to surface features.

B. Wyoming

Coal bearing rock in Wyoming ranges in age from Lower Cretaceous to Eocene (Tertiary). Reserves are mapped in rocks from Upper Cretaceous age to Eocene. Owing to their relative youth and simple geologic history, Wyoming coals are of lower rank than Illinois coals.

Illinois: Comparative Coal
Reserves - Illinois State Geological Survey
and U.S. Bureau of Mines Bases
(millions of tons)

County	Remaining Coal Reserves (Illinois State Geological Survey	Amended Coal Reserve Base (U.S. Bureau of Mines	Difference (1-2)
Adams	6.2	0.0	6.2
Bond	2,756.4†	1,831.4	925.0
*√Brown	0.0	-	-
Bureau	1,843.1	1,029.4	813.7
*√Calhoun	0.0	-	-
Cass	313.0	13.1	299.9
*Champaign	181.9†	-	-
Christian	5,040.7†	3,347.4	1,693.3
Clark	1,219.5†	168.5	1,051.0
*Clay	1,619.1†	-	-
Clinton	3,788.7†	1,322.5	2,466.2
Coles	356.2†	80.7	275.5
Crawford	2,406.2	442.6	1,963.6
*Cumberland	333.5	-	-
*DeWitt	173.6†	-	-
Douglas	747.9†	411.7	336.2
Edgar	2,992.2†	1,749.9	1,242.3
Edwards	1,715.9†	54.0	1,661.9
*Effingham	1,785.8	-	-
Fayette	3,228.4	1,173.7	2,054.7
Franklin	5,121.3	3,038.4	2,082.9
Fulton	308.5	220.5	88.0
Gallatin	3,748.7	1,761.1	1,985.6
Greene	108.0	52.1	55.9
Grundy	531.2	246.0	285.2
Hamilton	4,813.8†	2,440.2	2,373.6
*√Hancock	0.0	-	-
*Hardin	3.6†	-	-
*√Henderson	0.0	-	-
Henry	442.9	28.3	414.6
Jackson	321.5	226.7	94.8
*Jasper	3,276.9†	-	-
Jefferson	5,288.7	1,800.6	3,488.1
Jersey	59.0	42.0	17.0
Kankakee	96.1	79.9	16.2
Knox	185.8	68.0	117.8
LaSalle	1,878.7	1,083.0	795.7
Lawrence	2,950.9†	893.6	2,057.3
Livingston	2,938.8	586.5	2,352.3
Logan	2,589.7†	813.7	1,176.0

County	Remaining Coal Reserves (Illinois State Geological Survey	Amended Coal Reserve Base (U.S. Bureau of Mines	Difference (1-2)
Macon	1,852.9†	439.3	1,413.6
Macoupin	6,245.6	3,421.1	2,824.5
*√McDonough	0.0	-	-
McLean	1,126.1†	421.0	705.1
Madison	2,002.0	1,366.5	635.5
Marion	1,966.7†	421.0	1,545.7
Marshall	1,089.5	358.0	731.5
*Mason	23.3†	-	-
Menard	1,075.8	1,460.0	(384.2)
Mercer	17.2	12.6	4.6
*Monroe	11.9	-	-
Montgomery	5,584.0†	3,906.6	1,677.4
Morgan	1,157.1	144.8	1.012.3
Moultrie	355.5†	123.1	232.4
Peoria	940.5	289.2	651.3
Perry	1,629.9	1,201.0	428.9
*Piatt	10.7†	-	-
*√Pike	0.0	-	-
Putnam	743.8†	588.9	154.9
Randolph	247.2	214.0	33.2
*Richland	2,125.8	-	-
Rock Island	20.1	12.8	7.3
St. Clair	1,907.2	951.4	955.8
Saline	3,747.5	2,553.4	1,194.1
Sangamon	5,393.0	3,540.0	1,853.0
*√Schuyler	0.0	-	-
Scott	33.0	0.1	32.9
Shelby	1,619.4	712.5	906.9
*√Stark	0.0	-	-
Tazewell	255.6	69.3	186.3
Vermillion	2,213.3	1,544.3	699.0
Wabash	1,456.6	262.0	1,194.6
*Warren	6.5	-	-
Washington	4,105.2	1,555.2	255.0
Wayne	4,624.1†	89.0	4,535.1
White	4,643.5†	992.5	3,651.0
*√Will	0.0	-	-
Williamson	2,755.4	1,573.1	1,182.3
Woodford	1,174.8†	213.9	960.9
86 Coal Counties	127,330.9 -5,289.1√		
79 Counties for Comparison	122,041.8	53,441.9	

* Counties not included in the United States Bureau of Mines Reserve Base of Bituminous Coal for Underground Mining for Illinois.

✓ Coal is 100 percent strippable (ISGS).

† Counties in Illinoi whose reserves are not differentiated into underground and strippable by the Illinois State Geological Survey. These counties usually do not contain strippable coal.

Note: The Illinois estimates do not exclude coal precluded from development by surface features. Coal in areas heavily drilled for oil have been excluded.

Sources: M. E. Hopkins and J. Simon, <u>Coal Resources in Illinois</u>, Illinois State Geological Survey, Illinois Mineral Notes No. 53, January 1974; and U.S. Bureau of Mines, <u>The Reserve Base of Bituminous Coal and Anthracite for Underground Mining in the Eastern United States</u>, IC8655, Table D-1.

Averitt (1973)[11] used the reserve estimate reported in Berryhill, <u>et al</u> (1950)[12] of original reserves of 121,553,850,000 short tons to determine his estimate for remaining reserves of 120,656 x 10^6 (of which 12,705 x 10^3 tons was bituminous coal and the rest, 107,951 x 10^6 short tons is subbituminous) simply by subtracting production to date. For the purposes of his appraisal, all lignite was classified as subbituminous coal. No coal under an overburden greater than 3,000 feet was included in the 1950 estimate. Averitt (1973) includes an unsupported 425,000 x 10^6 short tons for total estimated hypothetical resources (USGS terminology) not found in the 1950 publication. This figure represents an estimate of resources present under an overburden of from 3,000-6,000 feet. These resources occur in unmapped and unexplored areas in known coal fields.

The estimates given in Berryhill are of original coal reserves in the ground before mining began, including that present under towns, etc.; they exclude all known areas of burned coal. The 1950 Berryhill report was based on USGS bulletins published to that date, plus information obtained from the then operating mine locations. A 1950 Coal Resources map produced by Berryhill, Brown, Burns and Combo, reports information based on 44 mine locations and 45 publications.[13] Recently some diamond drilling has been undertaken by the USGS (on contract). The results so far are contained in two open file reports on reserves but are not included in this report. In 1950, calculation of reserves on this basis was the only practicable method for Wyoming where many coal areas had not been surveyed and where total production was still insignificant compared to total reserves. At best the estimates available to date are very conservative totals.[14] The estimate of reserves presented in the original Wyoming report in 1950 were subdivided according to rank (ASTM) of coal, thickness of beds, and thickness of overburden (after USGS). The thickness ranges of coal seams are those originally recommended by the National Bituminous Coal Council. The thickness ranges of overburden are also those used by the USGS.

For the 1950 study, estimates were computed for individual beds and individual townships with few exceptions using information from maps, outcrops, drill holes, mines, and the localities and thicknesses of measured sections:

1. A continuous bed was considered to underlie an area enclosed by a line of outcrop;

2. For all other beds within each thickness category the coal was assumed to extend within a semi-circular area one-half mile from a length of outcrop;

3. From an isolated mine working, an arc of maximum radius of one-half mile from the exposed face was assumed to be underlain by coal;

4. Around an isolated drill hole, a circle with a radius of one-half mile was defined.

These data do not provide control for the presence of workable thicknesses because they do not account for variability in thickness over great distances, for direction of projection of data, or correlation of data.

After the total area of coal occurrence had been determined, the estimates were divided into sub-areas of measured, indicated and inferred reserves. These reliability categories for Wyoming reserves were those formulated jointly by the USGS and the U.S. Bureau of Mines.

Tonnage estimates are calculated by weights of 1,700 tons/acre foot for bituminous coal and 1,800 tons for subbituminous coal. Measured reserves include beds for which positive information as to thickness and extent is available from surveys of the outcrop and from mine workings and drill records. Points of observation are generally about one-half mile apart. Indicated reserves are computed partly from specific measurements and partly from the projection of visible data for considerable distances on geologic evidence. In general the points of observation are approximately one mile apart, or as much as one and one-half miles for beds of known continuity. Inferred reserves are those for which estimates are based largely on broad knowledge of of the geologic characteristics of the bed or region, supported by few or no actual exposures or measurements. In general, inferred reserves lie outside the limits defined above for measured and indicated reserves, but only in areas where there is good evidence for believing that coal, in the thickness required and of a given rank, is actually present.[15] Reserves based on overburden categories that extend to 6,000 feet, that are mapped only in areas adjacent to surface exposures and abandoned mines can result only in an overall gross estimate of reserves on the basis of available records. These reserves are confined to measured reserves because of the limited projectability of coal data. Reserve estimates made on this basis are the exception in the Illinois estimates, used only when compilation based on overburden is rendered impracticable by coals that thin and thicken abruptly.

The average thickness used in the calculations was a weighted average of all thickness estimates within an area, representing total thickness minus partings greater than three-eighths inch in thickness. Corrections for dip of beds were employed in estimating reserves in all coal beds dipping between 18 and 78 degrees. Beds dipping less than 18 degrees were considered horizontal, while those dipping more than 78 degress were treated as vertical. Since all apparent thicknesses are greater than true thicknesses, this results in overall thickness estimates approximately 20 percent greater than warranted.

Recent work in reserve estimate revision in Wyoming coal fields has been published by G. B. Glass of the Wyoming Geological Survey. Glass' estimates on original coal resources of the Hanna Coal Field are revised from Berryhill et al (1950) to 3,918,590,000 tons (≤3,000 feet overburden). The remaining resource is calculated to be 3,828,169,616 tons, using an 80 percent recoverability factor for strip mine production to January 1, 1972.[16] Glass' estimate for the 0-1,000 feet category (he termed it "a guess") was merely a percentage of the remaining resource as are his estimates of a strippable resource figure. However, the estimate is considered better (less conservative) than that given by the Bureau of Mines (IC8538) and, while recognized as "at best a crude approximation," is believed by Glass to be at least of the right order of magnitude.

Total strippable reserves of 23 billion tons were estimated for seven major Wyoming coal areas active in 1969 (USBM, 1972). Surface mining accounts for 100 percent of all the coal mined in Wyoming (G. B. Glass, 1974). The 1972 report by the Bureau of Mines (IC8538) summarized and interpreted information available to them on strippable coal in Wyoming. Cursory examinations were made of the coalfields and strip mines; and factors that would affect strip mining, particularly coal and overburden characteristics, were noted. Coal outcrop and reserve data were obtained from reports of the USGS. Firms engaged in exploration and acquisition of coal lands in Wyoming were consulted to obtain supplemental information. Obviously, Wyoming reserve base estimates would be reduced significantly by the curtailment of surface mining operations.

Where the drill hole data for defining strip limits or adequate topographic maps were not available, strippable deposits were defined by using the stratigraphic interval between the coalbed of interest and an overlying coalbed, together with maps showing surface traces of coalbeds to locate stripping limits. This method must assume that the nature of the coalbeds so included in the estimates are known.

In Wyoming the technologic and cost feasibility of strip coal mining is closely related to the breaking characteristics of the strata, ratios of overburden to coalbed thickness, and coal characteristics. Criteria used for defining the cutoff limits of strippable deposits include: 1) a minimum coalbed thickness of 5 feet; 2) an overburden-to-coal ratio of less than 10 cubic yards of overburden per ton of coal; and 3) a total overburden thickness of less than 120 feet except where strata-breaking characteristics appear ideal and coal thickness is more than 20 feet in single or multiple beds.

The total strippable reserves were estimated without regard to a recoverability factor or to a detailed analysis of coal samples (grade). In Wyoming, significantly large areas of coal, reportedly mined up to 1969, were deleted from the strippable reserve estimates.

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APPENDIX 1

Recovery Percentage of Bituminous Coal Deposits in Underground Mines

In a statistical sample of 200 underground mines, selected as representative of operating mines, recoverability ranged from 20 to 91 percent. The average recoverability was 57.0 $\pm$ 1.7 percent with a 95 percent confidence limit. These estimates are in the context of 1968 technology and economics. Hence, the traditionally used and quoted recoverability percentage of 50 percent is indiscriminate of all coal deposits. The lower figures supposedly compensated for losses not ordinarily included at the mine.

Six factors significantly affecting recoverability were identified by the U.S. Bureau of Mines: 1) the pillaring system, 2) top rock conditions, 3) bottom rock conditions, 4) coal bed thickness, 5) marketability, and 6) productivity. Factors 1-4 are of importance when choosing a mining method. Factors 5-6 vary with technology, mining method and economics. For example, a longwall mining system offers advantages of recovery near that attainable with conventional or continuous systems, as well as efficient mining under extremely deep cover or weak roof conditions. Unrecoverable roof support costs are minimized, since the primary supports move with the unit.(1) Five mining equipment features adversely affect the recovery percentage in some mines: 1) the inability to adjust to variability in coal bed thickness, 2) high cost of equipment, 3) weight of equipment, 4) size and maneuverability, and 5) inability to mine rock extensively.(2) A much greater percentage of coal can be recovered in surface mines, approximately 85 to 90 percent compared to the assumed

50 percent in underground mines. Surface mining increases the amount of potentially mineable coal because surface mining machinery recovers thin coal, coal from multiple beds and coal from split seams regardless of roof conditions.[3] No significant difference in the recovery percentage in underground mines was noted when comparing 1) the mining method of multiple entry with the room and pillar method, 2) the various types and combinations of mining equipment, 3) different annual production outputs, 4) different thicknesses of overburden when less than 1,000 feet, and 5) different number of days the mine operated.

Physical conditions which impede mineability and thereby effectively lower recovery percentages include 1) bad roof conditions (i.e., rapid deterioration of overlying rock), 2) soft underlying rock, 3) faults, 4) thinned areas, 5) rolls or undulations, 6) wants (i.e., clay parting, veins, channels, etc.). Measured losses consisted only of unmined coal for which an accurate planimetric measure could be made on a mine map. (Mine maps are in some cases inaccurate and not to scale.) Some coal is termed "unavailable" because it is purposely left unmined (i.e., pillars). Economic-technologic losses include coal recovery that is not feasible by existing methods and quipment, physically, economically or legally. Some losses go unmeasured in whole or partial pillars, spillage, coal fines and washery refuse.

Reevaluation of reserves or resources as a result of changes in technology and economics may ultimately come in part from these categories. As "lost" coal has a rather permanent connotation, perhaps these quantities should be otherwise categorized. A concept of estimated secondary recovery may be useful. If measured losses had been eliminated in the total tonnage, the Bureau of Mines estimate would have been 65 percent recoverability. This compares favorably with the 65.1 percent average value of recovery made by mine officials.

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APPENDIX 2

Strip Mining

The amount of coal mined and potentially mineable increases through the years concomitantly with increases in the size and efficiency of strip mining machinery.(1) Environmental pressures generally oppose surface mining. However, since strippable reserves are being depleted, especially in the East, an increase in underground mining is expected in the coming years.(2) Aspects bearing on reserve estimation of stripping coal include stripping ratio, thickness of overburden, and mineable reserves. The stripping ratio is the ratio of the overburden volume to the amount of mineral reserves, already stripped or to be stripped, expressed in volumetric or weight units.(3) Averitt (1968) [p.C4], suggests that 30:1 overburden/coal ratio is technically feasible as a maximum for "present and near future" strip mining though a much lower ratio may be dictated by economics (e.g., the costs of transporting the coal and waste).

The limit of stripping extends to the point where the cost equals that of developing like units by underground mining. The "economic" stripping ratio (coal/overburden) takes into consideration the respective swelling indices of coal and overburden. The estimation of mineable reserves is dependent on the mining method and the equipment used.

The overburden range for a given thickness of strippable coal used by the USGS (Averitt, 1968)(4) is:

Depth (feet)	Thickness (inches)
0 - 40	14 - 28
40 - 60	28 - 42
60 - 90	42

The thickness categories are equal to those selected for the classification of underground mining for bituminous and anthracite coal.

Strip mining greatly increases the amount of ultimately recoverable coal in the U.S. It makes possible the mining of coal under shallow overburden, in thin beds and multiple beds, in badly faulted areas, or in small pockets. Recoverability may be a high as 90 percent, though an average figure of 80 percent is generally accepted as a fair average for most strip mining operations. Average output per day is approximately 100 percent higher, overall recovery is 60 percent higher, and operating costs are 25-30 percent lower than in underground mining.[5] The limitation of surface mining, however, is that with presently available machinery it is difficult to surface mine at depths greater than 180 feet.[6] Losses in strip mining are primarily in besset areas (plain areas between the upper edge of the quarry and the foot of quarry walls), in areas below the bottom bench, in wedges and due to contamination.

In auger mining, the maximum possible recovery is about 75 percent and the average recoverability factor has been closer to 50 percent. These figures may be compared to approximately 60 percent for underground mines (USBM, No. 7109).[7] When the economic limit is met in normal surface mining operations, an auger operation may be feasible if the tonnage is insufficient or the seam is too thin for economic underground operations.

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APPENDIX 3

Coal Rank

Rank is the major basis for the differentiation of coal in resource calculation. Geologically, it is a measure of the relative degree of metamorphism, the progressive alteration of mineral matter in the natural series from lignite to anthracite. Classification by rank is based on the percent of fixed carbon and calorific value (heat content) in Btu/lb. calculated on the mineral-matter-free basis.[1] Fixed carbon is the remaining solid combustible matter after the removal of moisture, ash and volatiles present in coal, expressed as as percent. Mineral matter is excluded because it does not reflect the degree of metamorphism of the coal. Classification of higher rank coals is based on fixed carbon on a dry basis while classification of lower rank coals is by calorific value on a moist basis. The agglomerating character is used to differentiate between certain adjacent groups. The agglomerating value is a measure of the binding qualities of coal determined by fusing tests in which no inert matter (ash) is heated with the sample. It is of importance in some new combustion and synthesis technologies.

Coals are classified as anthracite if non-agglomerating and if the fixed carbon content is greater than or equal to 86 percent on a dry, mineral-matter-free basis; if agglomerating, they are classified as low volitile bituminous. Coals with a calorific value between 10,500 and 11,500 Btu/lb. on a moist mineral-matter-free basis are classified according to their agglomerating behavior. The classification of coals according to other strictly objective rank criterion based on physical/chemical characteristics of coal, i.e., reflectence of the vitrinite component of coal, is intended as a guide for utilization behavior.[2]

The coal grade is determined by the amount of ash (a highly variable constituent; never greater than one percent), sulfur and other deleterious trace elements present in the coal.

Classification according to sulfur content has typically consisted of three categories: 102 ($\leq$1%), medium (1-2%) and high ($\geq$2%). Sulfur occurs in coals in two forms, organic (thiosulfates and sulfites) and inorganic (pyrite, marcasite, and hydrated ferrous sulfate). While these categories have lately been extensively subdivided, the work has not been related to the wide differences in the Btu content of the coal. Thus, both within rank, and especially across ranks, the tonnages of coal within sulfur categories are not comparable for purposes of utilization.

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PRODUCTIVITY IN UNDERGROUND MINING

Productivity in underground mines increased steadily from 1960 until the passage of the 1969 Federal Coal Mine Health and Safety Act. As shown in Table 1, productivity increased from 10.64 tons/man-day in 1960 to 14.00 tons/man-day in 1965, and reached 15.61 tons/man-day in 1969, before dropping drastically because of the new restrictions. Although tons/man-day increased each year from 1960 to 1969, the rate of increase declined considerably in the later years; while productivity increased substantially over the decade, it appeared to be leveling out.

The reasons for changes in productivity and the amount of change attributed to any particular factor are difficult to determine. The main reason for this is that individual mines vary considerably in every factor which might influence productivity. Thus it is extremely difficult to compare mines on the basis of one or a group of factors. And, the factors are not independent. For example, for thick even seams, a continuous mining system may be most effective but, for thin seams a conventional system may be better. Alternatively, rubber-tired haulage cars are best under certain conditions, but if the mine floor is soft, use of rail cars may be necessary. This last problem has sometimes been circumvented by leaving a layer of coal for a haulage road. Now, however, this may have been made illegal by the first provisions of the new safety law.

The best data for evaluating productivity gains brought about by new machinery would be comparisons of productivity before and after the equipment was installed. Little or no data of this sort are available.

Table 1

Productivity per Man-Day Underground

Year	Total	Inter-Year Difference	Loading Machines	Continuous Mining
1960	10.64			
		+.77		
1961	11.41			
		+.56		
1962	11.97			
		+.81		
1963	12.78			
		+.96		
1964	13.74			
		+.26		
1965	14.00			
		+.64		
1966	14.64			
		+.43		
1967	15.07			
		+.37		
1968	15.40			
		+.21		
1969	15.61			
		-1.86		
1970	13.75			
		-1.72		
1971	12.03		11.00	13.00
		-.12		
1972	11.91		10.00	12.50
		-.16		
1973	11.75		9.75	12.25

Sources: 1960-1970 Minerals Yearbook.
1971-1973 Coal Age.

Some of the factors which affect productivity are:

a) geological conditions,
b) method of mining,
c) method of loading,
d) type of haulage from the face,
e) type of haulage within the mine,
f) interfaces between b, c, d, and e,
g) peripheral or supportive equipment,
h) training of miners, and
i) safety regulations.

These factors influence productivity in a direct way.

There are other quantities which are correlated with productivity the effect of which is felt only through changes in the above. For example, Risser[1] found a correlation between productivity and mine size; bigger companies usually had higher output per man-day than small companies. Over a period of time, average productivity increased because of the closing of smaller less efficient mines which were unable to use fully the advantages of new equipment or techniques. In fact, for the period 1965 to 1969, the increase in productivity was accompanied by a decrease in the number of underground mines from 5,280 to 3,097.

Geological conditions influence not only the level of productivity that can be achieved with a particular equipment configuration, but also dictate which equipment can be used at a particular site. Some relevant factors are depth of cover (determining roof pressure), thickness of seam, evenness of the seam (faults, etc.), type of roof, type of bottom, and the presence of water, gas, or partings. Differences in these conditions lead to different production rates and can also lead to production changes over time if new coal beds are discoverd or if the most easily mined coal beds become depleted. There are no data indicating that this has yet had an effect. Average seam thickness, for example, stayed at about 5.3 feet between 1945 and 1965.(2) However, eventually depletion of current economically recoverable coal must begin to have a retarding effect on productivity.

In the past, much of the increase in underground mine productivity could be attributed to increased mechanization. By 1970, however, mining had become almost fully mechanized, although not automated. In 1960, 86.3 percent of all coal produced was mechanically loaded, in 1965 it was 89.2 percent, and by 1969 the percentage was up to 96.6 percent. While some increase in productivity can be attributed to this, the effect since 1965 has been slight. Most gains in this period must be attributed to improvements in machinery or techniques.

There are three basic mining methods currently being used: conventional (using room and pillar layouts), continuous (also using room and pillar layouts), and longwall. Recently shortwall mining has been developed. In this sytem a longwall layout is used and the hydraulic roof supports of a longwall system are retained, but the mining is done by a continuous miner. The shortwall system allows longwall type mining to be done without the purchase of longwall equipment. It is also reportedly safer than longwalling.(3) To an extent the different systems are noncompetitive in that they are each best used in different circumstances. Also, since longwalling and shortwalling have only recently been extensively used in the United States, and then only under adverse conditions, their productivity rates are difficult to determine. For example, in 1968, 1.8 percent of all underground production was from longwalls. By 1973, this had increased to only 2.6 percent. It is reasonable to expect that longwall productivity will increase relative to other types of mining as longwalling becomes more widely used. There may be an indication of this in that longwall losses due to the 1969 Safety Act were less than for other types of mining.[4]

It is difficult to determine the relative productivities of continuous and conventional mining. Up to 1970, the Bureau of Mines' Yearbooks did not give productivity estimates for the different mining methods. From 1971 until 1973, productivity for loading machines dropped from 11.00 tons/man-day to 9.75 tons/man-day while that for continuous miners dropped from 13.00 to 12.25.[5] The relative decreases agrees with the results of Straton's 1972 study in which it was found that continuous mining suffered less from the new regulations.[6] For continuous miners and loading machines, production, number of mines, and number of units for 1965 to 1969 are shown in Table 2. While total production increased 4.4 percent from 1965 to 1969, production by continuous miners increased 21.6 percent by 1969, accounting for 49.7 percent of all underground production compared to 42.7 percent in 1965. Meanwhile conventional mining, as indicated by mechanical cutter production, decreased by 10.6 percent, from 53.9 percent of the total to 46.2 percent. The number of cutters decreased 41.8 percent while the number of continuous miners increased 29 percent. These figures indicate that while continuous miners were taking over more production, conventional mining was actually becoming more efficient. There may be several reasons for this. First, continuous miners are used for purposes that are not strictly limited to taking coal from the face. They are also used, for example, in driving entries. Second, they are a newer development and may have taken over in mines where conventional mining was inefficient.

On the other hand, in 1966 Risser stated that conventional mining was catching up to continuous mining produc-

Table 2

Production by Mining Method

		Mobile Loading Machines			Continuous Miners			Longwall		Production Percentages			Cutting Machines			Using More Than Type of Loading Device
Year	Total Production (thousands of tons)	Production (thousands of tons)	Number of Mines	Number of Units	Production (thousands of tons	Number of Mines	Number of Units	Production (thousands of tons	Number of Units	Loaders	Long-Wall	Con-tinuous	Production (thousands of tons	Number of Units	Percent of Pro-duction	Number of Mines
1965	332,651	151,682	987*	2394	141,938	275*	1218			45.6		42.7	179,440	4784	53.9	173
1966	338,524	159,959	1206*	2539	155,052	349*	1380			47.2		45.8	172,503	4311	51.0	183
1967	349,133	158,426	1218	2518	165,571	350*	1412	3,232	15	45.4	0.9	47.4	174,424	3663	49.1	190
1968	344,142	159,700	1198	2542	163,816	385*	1487	4,633	22	46.4	1.3	47.6	166,565	3060	48.4	181
1969	847,132	155,400	1210	2466	172,642	385*	1571	6,344	28	44.8	1.8	49.7	160,375	2779	46.2	168

* Mines using only continuous miners (or only loaders).

tivity.[7] Increases in continuous mining productivity were probably due to improvements in loading equipment. Past increases in productivity of continuous miners was probably caused by improvements in peripheral equipment. Risser stated that roof bolting allowed greater use of large continuous miners by eliminating the need for post type roof supports, thus giving the miners the necessary room to manuever.[8] Developments in haulage away from the mines have also increased productivity. Partly because of tramming time between faces and partly because of inefficient hauling, continuous miners operate less than 30 percent of the time, although their instantaneous mining rates may be 15 tons/ minute.[9] This indicates that, at least under favorable conditions, continuous miner productivity could be considerably increased. It should be noted that while the percentage of coal mined by continuous miners increased less than 4 percent between 1966 and 1969, it increased nearly 10 percent to 59.3 percent from 1969 to 1973.

Continuous miners are in operation less than 30 percent of the time. In 1966, Risser stated that both the mobile loader and the continuous miner, if they could be operated continuously, are capable of loading in three hours as much coal as they commonly load in a full shift today.[10] Calder notes that continuous miners are used only two to three hours per shift, that because of rising costs of roof control, larger machines will not be usable, that no more breakthroughs such as roof bolting are in sight, and, that because of this, new gains in productivity must come from the operation of equipment that moves the mined coal away from the face to some point where haulage capacity is not limited.[11] The way this is done is strongly connected with the mining system.

In conventional mining, the coal must be loaded from the floor. It can be loaded directly onto a conveyor or into shuttle cars which discharge into mine cars or onto a more permanent conveyor. The continuous miner can load directly onto a conveyor, into a shuttle or surge car, or onto the ground. Longwall mining is best suited for continuous haulage because, by the nature of the system, coal is placed directly onto a stationary conveyor after being taken from the face. While it is difficult to glean specific information about the different operations from Bureau of Mines statistics, they do show that production from mines using conveyors (and possibly other haulage equipment) increased 19 percent from 1965 to 1969. During the same period, the number of mines using some sort of conveyor haulage increased 14.6 percent and the number of conveyor units increased 28.9 percent. In the same period production at mines using rubber tired and rail mine cars decreased 36.5 percent and 12.7 percent, respectively, and the number of shuttle cars increased 4.3 percent. This seems to show that conveyors were replacing mine cars for longer haulages but that shuttle cars were still the main mode of haulage from the face.

In fact, the difficulties in connecting a conveyor to a loading machine or continuous miner have only recently been partially resolved. Herman[12] describes an all-conveyor system in a mine in Illinois. In this system, a continuous miner discharges into a surge car which unloads onto a bridge conveyor which in turn is connected to a Serpentix conveyor. He claims an increase in coal production per shift from 775 tons to 1,075 tons. Garzes[13] reports on the replacement of a shuttle car system with a conveyor system because the mine floor consisted of fire clay which softens and becomes impassable to shuttle cars when water is present. He estimated production potential to be 30 percent higher with the conveyor system. He also remarks that conveyor use has been extensive in seams under 40 inches thick but that their use in thick seams has been declining. The advantages of shuttle cars also decreases as the distance they must travel increases. According to Coal Age Mining Handbook, the maximum distance for a shuttle car run is about 500 feet with two cars per face unit.(14)

In the period 1965 to 1969, production in mines using conveyors increased while those using mine cars decreased. This indicates that once the coal has been transported by shuttle car or bridge conveyor away from the immediate mining area to a more permanent area of the mine, it is increasingly being transported from that point by conveyors. This agrees with Laird's statement that:

> ... present day accepted practice is to transport coal, by belt conveyor, from the butt entry coal production sections to what we call the main line. This method has been proved to be as economical, if not more economical, flexible, efficient, and the most rapid way of getting the coal to the mine car or main line belt conveyor.(15)

He discusses the costs and advantages of various combinations of conveyors and track haulage. For the first 5,000 feet of main entry he finds that an all belt haulage system is cheapest but, as the distance is increased, other systems become cheaper.

Hydraulic and pneumatic haulage systems are now being studied. In these systems, the coal is crushed at the face and then placed into a felxible pipeline through which air or water is flowing. Both systems have the disadvantage of breaking the coal into even smaller pieces as it travels but are clearly safer and provide a truly continuous, uninterrupted flow of coal from the face.[16] Calder feels that while pneumatic haulage is not efficient because of the required amount of air, hydraulic haulage has great potential.[17]

Any system of mining employs equipment that is not directly involved in taking coal from the face. However, the efficiency of this peripheral equipment does affect productivity. Probably the most important items are roof supports. For longwall mining, self-advancing hydraulic roof supports undoubtedly increased productivity by freeing men of the job of moving the supports by hand. The newer, more powerful four-leg supports, which support up to 700 tons[18] have probably incrased productivity by decreasing roof pressure problems.

It has already been noted that roof bolting has been very important, especially in connection with the use of continuous miners and other large, mobile equipment. The number of drills used in roof bolting increased from 2,529 to 2,980 or 17.8 percent between 1965 and 1969. Recently, roof bolters have been attached to continuous miners in such a way that bolting can keep pace with the miner.[19] A further development in roof support is the injection of polymers into holes drilled into the roof to bond roof rocks together.[20]

Improvement of any piece of machinery, or a general improvement in the efficiency of the mining layout or system increases productivity. For example, Hinkle[21] describes the development and use of front-end loaders in underground mining. This piece of equipment is very flexible and is used for mine cleaning operations as well as coal loading. Hinkle suggests productivity increases will result from its greater use.

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THE AVAILABILITY OF PUBLIC

LAND FOR COAL MINING

Not all public lands are available for coal mining. The control of the public domain is placed in Congress by the U.S. Constitution, Article IV Section 3. Under the Constitution, the Congress has the power to set aside portions of the public domain from sale or other disposition. This Congressional power may be delegated to the Executive branch. In dealing with the availability of public land two questions must be answered. The first is whether the land is open to mining under any general legislation. The second is whether or not the land has been "withdrawn" from the operation of the general mining laws.

The general mining laws reflect the policy that Congress adopts concerning the use of our natural resources. Until 1849, the Treasury Department had jurisdiction over public lands and the policy was to sell land to raise revenue. The next phase of government policy was to induce development of the western lands.[1] Accordingly, title in fee simple absolute (complete ownership), was granted to anyone who would develop the mineral resources. The final shift in policy

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[1]This discussion predominately centers upon western land. Most land East of the Mississippi was under private ownership by the time legislation was inaugurated dealing with mining policy.

developed after the turn of the century, during the administration of Theodore Roosevelt. At this time, the concept of conserving natural resources began to develop. The major change in policy was the decision to encourage development of the land without transfering complete title to the developer.

The initial legislation reflecting the conservation policy was the Leasing Act of 1920 (30 USC §§ 181 et seq). The act established a leasing system under which title to the lands being developed would remain in the U.S. The act expressly classified as leasable or non-leasable the various kinds of federal lands containing coal.[2] Included generally is the public domain, together with the national forest reserves (except for lands acquired under the Appalachian Forest Act). In this sense, the public domain includes such lands as are subject to sale or disposal under the general land laws of the U.S. Expressly excluded are those lands in incorporated cities, towns, and villages and in national parks and monuments, those acquired under Acts subsequent to February 25, 1920, and, with exception, lands within the naval petroleum and oil-shale reserves.

As noted, the Mineral Leasing Act does not deal with lands acquired under Acts subsequent to February 25, 1920. Accordingly, in 1947, the Congress enacted the Acquired Lands Act (30 USC §§ 351 et seq). "Acquired lands" are lands of

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[2]The act, as originally enacted, dealt with deposits of coal, phosphate, sodium, potassium, oil, etc. This paper refers only to the aspects of this and other legislation that deal with coal. But, the reader should be aware of the entire scope.

the U.S. which either were never part of the public domain or, although once part thereof, are in private or state ownership at the time of their acquisition by the federal government. Specifically included in this act is Alaska. In general, this act adopts the mechanics of the leasing act.

Finally, the Multiple Mineral Development Act of 1954 requires consideration in determining the general availability of public land. This act is designed to deal with situations arising where land may be valuable for other minerals in addition to coal.

Having determined the general availability of public land under the various leasing provisions, it is necessary to determine if such lands have been set aside by the Congress or the Executive branch for a special public use (i.e., forest, parks, Indian reservations) and are not subject to disposal under public land laws unless Congress has decreed to the contrary. Withdrawn lands are the equivalent of reserved lands but considered more temporary and the terms are used interchangeably. Current withdrawals are based upon one or more of three bases of authority.

1. Withdrawals by Congress.
2. Withdrawals pursuant to specific Congressional delegations of power.
3. Withdrawals pursuant to general Congressional delegations of power.

Of these three areas, the great preponderance of withdrawals is made by the Executive branch pursuant to general delegations of power.

The President's authority to withdraw land from disposition under the general land laws comes from two sources. The President possesses express authority under the Pickett Act (43 USC 141-43) and he possesses implied authority under the United States Supreme Court decision in U.S. vs. Midwest Oil. The Pickett Act (also referred to as the Withdrawal Act) delegated to the President the broad, discretionary power to temporarily[3] withdraw public lands from sale or entry. But, prior to the enactment of the Pickett Act, President Taft had withdrawn certain lands in California and Wyoming. The constitutionality of this withdrawal was tested in U.S. vs. Midwest Oil Co. In that case, the Supreme Court noted that the executive branch could not create a power where none existed, but that the withdrawal of public lands raised a presumption that such power was exercised with the consent of Congress. Emerging from the decision, therefore, is an Executive with broad supervisory powers over public lands, limited only by expressly declared Congressional policy.

It is important to determine whether a withdrawal has been made under the Pickett Act or under the President's implied withdrawal power. Decisions of the Department of the Interior have held that Pickett Act withdrawals do not bar

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[3] In this context, temporary is used in the sense that the withdrawals may be revoked by the President or Congress, but they remain in force in the absence of such revocation.

leasing. But, withdrawals made pursuant to the authority of the "Midwest" case can effectively bar leasing if so provided in the withdrawal order.

Under Executive Order No. 10355, the President delegated his withdrawal powers to the Secretary of the Interior. The announced policy of the Secretary is to keep withdrawals to a minimum, to permit maximum public use of withdrawn land consistent with the purpose of the withdrawal, to review withdrawals periodically, and to revoke withdrawals when they are no longer necessary. Since 1935, withdrawal orders have been published in the Federal Register. These are the orders that must be reviewed to determine if leasing is forbidden under the Executive's implied powers of withdrawal.

NATIONAL ENVIRONMENTAL POLICY ACT

The National Environmental Policy Act of 1969 (hereinafter NEPA), was written to establish a uniform policy of the nations' role in dealing with the environment.

> The purposes of this Act are: To declare a national policy which will encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Policy.[1]

Accordingly, the general policy is stated in Section 101:

> ...it is the continuing policy of the Federal Government...to use all praticable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exists in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.[2]

Schematically, the NEPA is divided into separate titles. Title I, entitled, "Declaration of National Policy," consists of five separate sections which set out the Act's policy and provide action forcing procedures to foster implementation of the policy. Title II, entitled, "Council on Environmental Quality," consists of seven sections which create the Council, establish its composition and authority, and outline its duties and functions.[3]

The provisions of the NEPA apply to all federal agencies and are to be interpreted as being supplementary to the policies and goals set forth in existing federal laws and programs. All federal agencies are expected to interpret policies, regulations, and statutes in accordance with the environmental policies set forth in NEPA and are required to do so unless existing law applicable to the agency's operations expressly prohibits or makes compliance impossible. The agencies must continue to review their policies, procedures and regulations and revise them whenever necessary to ensure full compliance with the Act.[4]

The most important provision of the Act is Section 102. Section 102 outlines steps which federal agencies are required to take to assure implementation of NEPA's broad environmental goals. Specifically, section 102(2)(c) requires:

> to the fullest extent possible..., all agencies of the Federal Government shall...include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed (impact) statement...

In understanding the effects of this section, two fundamental questions must be answered: 1) For what actions is an impact statement to be prepared; and, 2) what steps are involved in the preparation of a statement.

While NEPA clearly requires the preparation of statements in connection with any major Federal action which may significantly affect the quality of the human environment, the question of NEPA's applicability for some courts has been whether the statutory mandate involves one or two separate analytical tests. The statutory language appears to suggest that proposed actions must first be major, then they must have potentially signficant effects on environmental quality. Not surprisingly, judicial opinion on the point is split, although most courts tend to prefer the two-test approach. None of the courts has gone so far, however, as to suggest that each test can be applied completely independent of the other. In practice, a "major Federal action" is likely to have "significant environmental effects," so that in most cases the distinction in the judicial analysis may not be critical.[5]

Some light is shed on the type of action that requires an impact statement in the Guidelines issued by the President's Council on Environmental Quality. Section 5(a)(ii) of the Guidelines states:

> 'Actions' include but are not limited to... Projects and continuing activities...involving a Federal lease, permit, license, certificate or other entitlement for use;...[6]

It appears from the Guidelines that whether an action is a "major" action or will have "significant" environmental impact depends not only upon the nature of the action, but on its magnitude and on the circumstances of the place where it is proposed to be taken. Taken in one place, an action may require an impact statement while in a different locale, the same type of action might not be a major action significantly affecting the quality of the human environment.[7]

<u>Citizens Organized to Defend Environment, Inc. v. Volpe</u>[8] illustrates the broad interpretation of what constitutes major actions that signficantly affect the quality of the human environment. The case involved permission for the new huge shovel used in surface mining, the "Gem of Egypt," to cross a federal aid highway. Since the crossing involved temporary re-routing of the highway, federal approvals were necessary under 23 U.S.C. 101(b) and associated regulations. Most of the approvals had occurred prior to the passage of NEPA and the only approval "reserved for future action was the right to approve the proposed future crossings after determining that the 'points of crossing would not adversely affect traffic operations on the Interstate highway facility.'" The court therefore held that the granting of additional approval under these circumstances was not "major federal action" requiring an impact statement.[9] However, the court did state:

> The Secretary's 1964 approval of the project agreement was a major federal action significantly affecting the human environment. This federal action included approval of the reservation in Consol of a right to cross I-70. One of the secondary environmental impacts was that the agreement would permit Consol to use the highway to facilitate continued strip mining. The environmental effect of strip mining, or more accurately the project agreement's impact upon the activity of strip mining as it affects the environment, would have been subject to the requirements of the NEPA had the Act been in force at the time.[10]

Thus, a relatively insignificant permit such as a highway crossing permit which would allow a large strip mining shovel to cross the highway, triggers an impact statement requirement, since the highway crossing permit in turn facilitates strip mining on private lands.[11]

Literally every federal permit can generate the need for an environmental impact statement. Another example, of the effect on coal, would be leasing. In the leasing process, the "major federal action" that may give rise to a need for an environmental impact statement is the act of issuing the lease or holding a competitive sale. The actual act of issuing a lease, in and of itself, has no effect at all on the environment. But, a lease confers upon the lessee rights to conduct exploratory and exploitive activities, such as drilling, and these activities do have environmental impact and may significantly affect the quality of the human environment. Accordingly, the statement must be prepared prior to the action which inevitably leads to consequences such as drilling, and in addition, the environmental impacts of these consequences must be thoroughly analyzed in that statement. Because the statement initially prepared for the lease issuance will cover the effects of all these actions, a subsequent statement need not be prepared prior to the Geological Survey giving its approval of specific lease exploratory or developmental activities. The "major federal action" is the lease issuance, not the subsequent incidental approvals.[12]

Given that am impact statement is required, the requirements are outlined in the provisions of section 102(2)(c):

> ...every agency of the Federal Government must "include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on
> (i) the environmental impact of the proposed action,
> (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,
> (iii) alternatives to the proposed action,
> (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and
> (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented."[13]

The impact statement also must describe and assess any adverse environmental effects which cannot be avoided should the proposal be implemented. Simply put, the environmental impact statement is nothing more than a device to assist the preparing agency in its decisionmaking by providing relevant information to that agency, other Federal agencies, the Council on Environmental Quality, etc., about the possible environmental consequences of the proposed action.[14]

The Guidelines provide for two versions of the impact statement, a "draft statement" and a "final statement." On completion, the draft statement is submitted to the Council on Environmental Quality and the comments of State and local agencies authorized to develop and enforce environmental standards are obtained. Comments of other federal agencies must also be obtained within thirty days. Then, following submission and review of federal, state and local comments, the final impact statement is prepared.[15]

With regard to the consideration of alternatives, the necessary depth of the considerations is unclear. In Udall v. FPC, the Supreme Court overturned the licensing of a hydroelectric power project on the Snake River because the FPC failed to adequately consider alternatives to the proposed action.[16] Some indication of the scope of the required discussion of alternatives is also provided by the CEQ Guidelines. Section 6(a)(iv) requires "a rigorous exploration and objective evaluation of alternative actions that might avoid some or all of the adverse environmental effects."[17]

Finally, what provisions of the Act, if any, provide a basis for court enforcement. It has been suggested that section 101(c) recognizes a legal right in every individual to a healthful environment. However, this conclusion is not supported in the legislative history of the Act.[18] In contrast to the non-enforceability by court action of 101(c) is 102(2)(c). The impact statement requirement has been enforced by means of a preliminary injunction in several cases. The notable ones are the trans-Alaska pipeline case, Wilderness Society v. Hickel, I.E.L.R. 20042, and the Gilham Dam case, Environmental Defense Fund, Inc. v. Corps of Engineers 2 ERC 1260.[19] However, while the courts have been quick to enjoin governmental agencies from proceeding until environmental impact has been considered, language in cases indicate that court review will be limited to a determination as to whether the administrator has acted in an arbitrary or capricious manner or otherwise not in accordance with law, or if the action failed to meet statutory procedural or constitutional requirements. In other words, the court will not substitute its judgment for that of the administrative agency on the merits of the proposed program but will only require that the agency comply with the procedural requirements of NEPA.[20] Besides 102(2)(c), it is unclear whether any other provision of NEPA may form the basis for a cause of action. Inasmuch as NEPA is primarily a statute that establishes procedures to ensure consideration of environmental factors in decisionmaking, it is submitted that other parts of NEPA were not intended by Congress to be court enforceable.

FOOTNOTES

1. Section 2, National Environmental Policy Act of 1969, Public Law 91-190, 83 Statute 852 (1970).

2. Ibid., Section 101.

3. 1 Commerce Clearing House Pollution Control Guide 5106.

4. Ibid. at 5116.

5. Supra, Note 3 at 5132-33.

6. Lindgren, David, "Conservation, The Environment and Federal Oil and Gas Operations: The Future Under the National Environmental Policy Act of 1969," 17 Rocky Mountain Mineral Law Institute 113 at 122, 1972.

7. Supra, Note 5 at 123.

8. 353 F Supplement 520.

9. Friedman, Frank B., "The Operational Impact of NEPA and Releated Environmental Law, Regulations, and Orders on Mineral Operations," 19 Rocky Mountain Mineral Institute 54, 1974.

10. Supra, Note 8 at 540.

11. Supra, Note 9 at 54.

12. Supra, Note 7 at 124.

13. Supra, Note 3 at 5127.

14. Ibid.

15. Supra, Note 6 at 126.

16. Ibid. at 129.

17. Ibid. at 131.

18. Supra, Note 6 at 135.

19. Ibid. at 136.

20. Lindberg, Charles S., "Environmental Delays Affecting Mineral Lessess on Public Lands," 18 Rocky Mountain Mineral Institute 45 at 70, 1973.

THE CLEAN AIR ACT

The Clean Air Amendments of 1970 [hereinafter, "the Act"] made drastic changes in the federal anti-air-pollution program. The Act represents a radical departure in legislative approach to the problem of air pollution. Instead of following the procedure of establishing air pollution standards commensurate with existing technological feasibility, Congress has shifted to a policy which forces technology to catch up with the newly promulgated standards.[1] With regard to coal,

> The Act served to strengthen the role of the federal government in air pollution enforcement activities, by empowering the U.S. Environmental Protection Agency to adopt mandatory (1) national ambient air quality standards for air pollutants which have an adverse effect on public health and welfare, (2) national new source performance standards for categories of stationary sources that contribute significantly to air pollution, and (3) national standards for "hazardous" air pollutants.[2]

Federal enforcement authority of air pollution controls is based on the assumption that primary responsibility for pollution control rests with the states and local governments.

The Act requires EPA to prescribe national primary and secondary ambient air quality standards for each air pollutant designated as having an adverse effect on public health and welfare. An ambient air quality standard measures air pollution in a given area from many different sources, rather than measuring the pollution from any particular source.[3] Primary and secondary standards are distinguished as follows:

> a) A primary air quality standards are ones, the attainment and maintenance of which in the judgment of the Administrator, based on such criteria and allowing an adequate margin of safety, are requisite to protect the public health.
>
> b) A secondary air quality standard is one, the attainment and maintenance of which in the judgment of the Administrator, based on such criteria, is requisite to protect the public from any known or anticipated adverse effects associated with the presence of such air pollutant in the ambient air.[4]

The primary standard, while based on the air quality criteria for that pollutant, also includes a margin of safety deemed adequate by the EPA to protect the public health from any adverse effect that science may not have yet discovered. A primary standard, therefore, represents a limit on the concentration of a pollutant in the atmosphere which, in the judgment of the EPA, must be maintained to protect the public health. A secondary standard, on the other hand, is a specific level of air quality designed to protect the public welfare from any known or anticipated adverse effects associated with the presence of the pollutant in the ambient air.[5] Specific national primary and secondary ambient air quality standards have been issued for particulate matter, sulfur oxides, carbon monoxide, photochemical oxidants, hydrocarbons, and nitrogen oxides. Of these, air quality standards for sulfur oxides bear heavily upon the coal industry.

Sulfur oxides in the air have various harmful effects on public health and welfare.[6] With regard to health, sulfur oxides are related to irritation of the respiratory system.[7] With regard to public welfare sulfur oxides increase the corrosion rates of various metals, contribute to the damage of electrical equipment of all kinds, and attack a variety of building materials as well as statutory and other works of art causing discoloration.[8] And, finally, sulfur oxide may cause acute or chronic leaf injury to plants.[9] Accordingly, national primary and secondary ambient air quality standards have been set out at 40 Code of Federal Regulations § 50.4-50.5.

The control of sulfur oxide weighs heavily upon the coal industry. The burning of coal produces about 60 percent of all sulfur oxides emissions with the majority of the coal being burned in electric power generation plants.[10] While the problem can be alleviated by use of low sulfur coal and various cleaning processes, the use of coal is affected to extent that air quality standards cannot be met.

The Act also authorizes the EPA to adopt standards of performance for categories of new and modified stationary sources of pollution. A standard of performance for a stationary source applied to emissions from only a single source and thus differs from a national ambient air quality standard.[11] The standards demand the best technology for each source as the goal of the standards is to prevent new pollution problems from developing. Among the facilities for which regulations have been adopted are municipal incinerators, cement plants, nitric acid plants, and sulfuric acid plants. While no standards for stationary sources dealing with coal have been set, among those sources slated for future regulation are coal cleaning plants.[12]

Finally, standards of performance are required by the Act for both hazardous air pollutants and mobile sources of pollution. However, neither of these areas bears a relation to the use of coal.

While the federal government is responsible for the creation of the various standards, the individual states are responsible for implementation. The Act requires each state to adopt and submit to the EPA a plant providing for the implementation, maintenance, and enforcement of the national ambient air standards.[13]

To aid the states in developing and carrying out implementation plans, the EPA, after consultation with state and local authorities, designated specific air quality control regions. The quality control regions include major intrastate areas and, where applicable, interstate areas overlapping the state's boundaries.[14]

> These regions . . . generally encompass portions of states, and are based on jurisdictional boundaries, urban concentrations, atmospheric conditions, and various other factors, so that all localities within the air quality control region have similar problems presumably requiring similar solutions . . . The more serious the pollution, the higher the priority, and the more stringent the control measures that will be required.[15]

For sulfur oxides, there are three categories of regions: Priority I, Priority II, or Priority III.[16]

Federal enforcement authority of air pollution controls is based on the assumption that primary responsibility for pollution control rests with the state and local governments.[17] The Act authorizes the Administrator to issue a compliance order to any person violating a requirement of an applicable state air implementation plan.[18] In addition, if the violations are widespread because of state inaction, after sufficient notice, the Administrator may assume federal enforcement until the state satisfies him that it will use its enforcement power.

> Any person who knowingly violates any requirement of an applicable state implementation plan during a period of federal enforcement, or who refuses to comply with an order issued by the Administrator, is subject to a fine of not more than $25,000 per day of violation, or to imprisonment for not more than one year, or both. If convicted for a violation committed after the first conviction, the person is subject to a fine of $50,000 per day of violation, or imprisonment for not more than two years, or both.[19]

and, with regard to required documentation,

> Any person who knowingly falsifies a statement, representation, or certification in any document required under the Act, or who falsifies or tampers with a measuring or monitoring device required under the Act, is subject to a fine not exceeding $10,000, or to imprisonment for not more than six months, or both.[20]

In addition, any person may commence a civil action on his own behalf against any person, including the United States, who is allegedly violating an emission standard or limitation. However, such a suit is not allowed if the Administrator or a state has begun and is diligently prosecuting a civil action.[21]

FOOTNOTES

1. 61 American Jurisprudence 2nd 832, 1972.

2. 1 Commerce Clearing House Pollution Control Guide 3801, 1975.

3. Marc Fleischaker and Mark Johnson, "The Clean Air Act," 19 The Practical Lawyer 53, 1973.

4. 42 USCA § 1857c-4, 1975 Supplement.

5. Supra, note 2 at 3011.

6. A thorough discussion of sulfur oxide as an air pollutant can be found in "Air Quality Criteria for Sulfur Oxides," published by the National Air Pollution Control Administration, Pub. No. AP-50, January 1969.

7. Ibid at 155.

8. Ibid at 159-160.

9. Ibid.

10. Supra, note 2 at 3031.

11. Supra, note 3 at 57.

12. A listing of all present and future sources for limitation is available at ¶ 3325 of the Commerce Clearing House Pollution Control Guide.

13. The requirements for the state plans include the following:

    a. The attainment of all national primary standards as expeditiously as practicable, but generally not later than three years after the date of approval of the plan [no later than January 31, 1975, unless a two-year extension is granted under 42 USC § 1857c-5(e)].

    b. The attainment of national secondary standards within a reasonable time.

    c. Emission limitations, schedules, and timetables for complying, and other necessary measures, including land use and transportation controls.

d. Assurances that the state will have adequate personnel, funding, and legal authority to carry out the implementation plan.

e. Intergovernmental cooperation.

f. The establishment and operation of appropriate measurement techniques to compile and analyze data on ambient air quality.

g. Authority to require owners or operators of stationary sources of pollution (such as industrial plants and other buildings that emit pollutants) to install, maintain, and use emission-monitoring devices, and to make periodic reports to the state on the nature and amount of emissions from these stationary sources.

h. Periodic inspection and testing of motor vehicles to the extent necessary and practical to enforce compliance with emission standards.

i. Authority to prevent the construction, modification, or operation of any new source of pollution that would prevent the attainment or maintenance of a national standard.

j. A procedure providing for review, prior to construction or modification, of the location of new sources.

k. Procedures to ease pollution during emergency high pollution episodes.

l. Authority to abate pollutant emissions on an emergency basis to prevent substantial danger to the health of persons.

m. Revision of the plant after public hearings whenever revision is necessary.

14. A geographical listing of these regions can be found in 40 Code of Federal Regulations, Part 81.

15. Supra, note 3.

16. The ambient concentration limits for the various sulfur oxide regions are listed at ¶ 4010 of Commerce Clearing House Pollution Control Guide.

17. Supra, note 2.

18. _Supra_, note 3 at 61.

19. _Ibid_.

20. _Ibid_.

21. _Ibid_ at 62.

THE FEDERAL WATER POLLUTION CONTROL ACT

On October 18, 1972, the Congress enacted the Federal Water Pollution Control Amendments of 1972 (hereinafter the "FWPCA") entirely replacing the Federal Water Pollution Control Act which included the Water Quality Act of 1965. The act is based on recognition of the fact that the nation's waters are already polluted and that existing technology is inadequate to permit immediate reduction of the pollution to acceptable limits. Congress did not impose any immediate water quality levels or discharge restrictions, but instead required that certain results be achieved by certain future dates. Primary responsibility to assure the reduction of pollution is placed on the states, with the federal government, through the Environmental Protection Agency, exercising general standard setting and oversight responsibilities.[1]

The FWPCA consists of five Titles.

> Titles I and II provide for research programs concerning water quality, and authorize federal grants to assist states to administer water-pollution-control programs and to construct publicly owned waste-treatment facilities. Title III mandates the establishment of effluent limitations that require industry to employ the "best practicable" pollution-control technology by July 1, 1983. Title IV establishes a national permit system under which local government, industry, and agriculture must obtain discharge permits from the EPA or an appropriate state agency before discharging any pollutants into navigable waters. 2

Title V includes some general provisions including authorization for citizen suits to enforce compliance with the FWPCA.

Title I deals with "Research and Related Programs" and includes an explanation of the goals and policy of the act. Among the duties delegated to the EPA is the preparation and development of programs to assist states in dealing with many areas of water pollution by providing grants based on the extent of the problem in the particular state. In addition, Title I also encourages interstate cooperation and compacts, research and dissemination of information, and scholarships and grants to educational institutions for the purpose of solving the water pollution problem. Section 107 is a provision dealing specifically with a coal related area. Under this section the EPA, in cooperation with the Appalachian Regional Commission and other Federal Agencies, is authorized to make grants or contracts dealing with the elimination of acid mine drainage and other forms of pollution from mining operations.[3]

Title II deals with "Grant for Construction of Treatment Works."

> In addition to the general training, research, and planning activities envisioned and funded under Title I, Congress, in Title II, authorized the EPA to offer to any state, municipality, or intermunicipal or interstate agency grants for the construction of publicly owned waste-treatment facilities, up to a maximum of 75 percent of the cost of construction...
>
> Title II also calls on the states to develop and implement by July 1976 areawide waste-treatment-management plans for those areas that, as a result of urban-industrial concentrations or other factors, have substantial water-quality control problems. 4

Title III deals with "Standards and Enforcement" and, for this reason, is probably the most important part of the act. The primary thrust is to establish limits, otherwise known as "effluent limitations" on pollutants dumped by so-called point sources[5] directly into navigable waters.[6] These effluent limitations are in addition to the water quality standards also required by the act. Prior to 1972, the discharge of pollutants was regulated solely by reference to the quality of the receiving water. The experience of prior legislation showed that water quality standards form a cumbersome basis for a pollution control program because of the difficulty in establishing a direct relationship between the quantity and quality of pollutant discharges and the resulting quality of the receiving water.[7] Therefore, Congress decided to complement the water quality standards program with an independent system of effluent limitations set by reference to control technology applicable to the source of the discharge rather than by reference to the quality of the receiving water. The water-quality based effluent limitations are determined by the state and are administered through the National Pollution Discharge Elimination System (hereinafter NPDES). Only where the source-based effluent limitations are not stringent enough to meet the water quality standards for the receiving water will reliance on water quality standards be required.[8]

Water quality standards are to be established for all navigable waters. Water quality standards classify each state's waters according to their use for recreation, propagation of fish and wildlife, public water supplies, agriculture, industry or navagation, and establish "water quality criteria" to support each designated use. Water quality criteria specify the minimum physical, chemical and biological parameters necessary to support the designated use of a given stream.[9] Each state has the primary responsibility for the establishment of standards for the navigable waters within its boundaries. However, these standards are subject to EPA approval[10] and the EPA may itself promulgate the standards where a state fails to take appropriate action. Once water quality standards are established for all the nation's waters, the implementation portion of the standards will be incorporated into the NPDES.[11] At least once every three years the water quality standards of each state must be reviewed by the appropriate state agency.[12]

Title IV deals with "Permits and Licenses Certification" and establishes the NPDES. Under the new provisions, it is unlawful for any person to discharge any pollutant directly into the navigable waters from any point source without having obtained a permit.[13] Section 401 provides that before any federal license or permit can be issued by any federal agency, the applicant must secure confirmation from the situs state that the proposed discharge will conform to the discharge limitations of the Act.[14] The Section 401 certificate states the discharge limitations, monitoring requirements, and other limitations upon which the issuance is conditioned.[15] Section 402 provides for the issuance of permits to discharge effluents into the nation's waters upon the condition that the discharge will comply with the applicable discharge limitations, water quality standards, and monitoring and reporting requirements of the Act. In other words, no discharge may take place without a Section 402 permit, but the permit is conditioned upon a state certification under Section 401. This two-tiered system serves as a double-check operation.[16]

Procedurally, a violation of the Act occurs whenever there has been a discharge of pollutants in violation of the permit system section.[17]

> Whenever the EPA finds that any person is violating any effluent limitation or standard of performance, any recordkeeping, reporting, or monitoring requirement, or any permit condition or limitation, it may issue an order requiring compliance with such standard, limitation, or requirement. If compliance is not forthcoming, it may assess a civil penalty up to a maximum of $10,000 per day. In addition, the EPA may commence a civil action for appropriate relief, including a permanent or temporary injunction...

And, there are possible criminal penalties.

> ...Any person who willfully or negligently violates any regulation or any condition of a federal or state permit is subject to a fine of not less than $2,500 nor more than $25,000 per day of violation, or imprisonment for not more than one year, or both. Upon a second or subsequent conviction, he shall be subject to a fine of not more than $50,000 per day of violation, or imprisonment for not more than two years, or both. Any person who knowingly makes false statement, representation, or certification in any application, record, report, plan, or other document filed or required to be maintained under the FWPCA, or who falsifies, tampers with, or knowingly renders inaccurate any monitoring device or method required to be maintained under the Act, is subject to a fine of not more than $10,000 or imprisonment for not more than six months, or both. 18

Title V deals with "General Provisions" among which are additional judicial procedures. Under Section 510, the states are expressly reserved the right to prosecute violators of state effluent limitations. Under Section 511(a), federal agencies other than EPA are reserved the right to enforce other laws and regulations "not inconsistent with this act. Citizen suits to enforce various provisions of the act are authorized in Section 505 by anyone "having an interest which is or may be adversely affected." Section 504 gives EPA emergency powers to enjoin the discharge of any pollutant which imposes imminent and substantial danger to health, welfare or livelihood. Section 508 also provides that no federal agency may enter into any contract to be performed at a facility operated in violation of the Act.[19]

The FWPCA and the Coal Industry:

The FWPCA has a great effect on coal mining from both the standpoint of the mining operation and from the standpoint of the industrial use of coal. During the mining operation, mine operators must be cognizant of any potential violations of either effluent limitations or water quality standards. Similarly, any industry may face similar effluent limitations with respect to its use of coal.

While there may be many potential forms of water pollution from coal mining, acid mine drainage[20] is the most prevalent and serious. Drainage from coal mines has been described as the nation's most serious and complex water pollution problem and the most costly to remedy. More than 3.5 million tons of acid mine water are discharged annually into the nation's streams and waters.[21] The most significant contribution of federal water pollution control legislation to the acid mine drainage problem is funding for research and development of control technology.[22] (see discussion of FWPCA - Title I) State legislative adoption of water quality standards applicable to intrastate waters is required by FWPCA. An example of the statutory response to the problem can be found in the Water Pollution Control Act of West Virginia.[23]

The Water Pollution Control Act of West Virginia ecompasses acid mine drainage in its definition of pollution.[24] The Act requires that a permit be obtained from the State Department of Natural Resources to "open, reopen, operate or abandon any mine...or dispose of any refuse...from any such mine...[if] the aforementioned activities cause...or might reasonably be expected to cause a discharge into or pollution of waters of the State..."[25] And, since a permit may be issued upon reasonable terms and conditions, the Department can require the treatment of acid mine drainage as a condition to open a mine.[26] Also under the authority of the Act, the Water Resources Board sets forth administrative regulations. These regulations include general acid mine control measures.

> (1) Mine water, refuse, and acid-producing materials must, where practicable, be handled and disposed of in a manner which will prevent or minimize acid production;
>
> (2) the amount of discharge must be regulated to equalize the daily flow into streams;
>
> (3) chemical treatment of acid drainage is required "under appropriate circumstances" to "mitigate its pollutional properties;" and
>
> (4) Mine sealing methods upon abandonment must be designed both to promote safety and to minimize the formation and discharge of acid mine drainage. 27

With regard to enforcement, the Department Chief is authorized to inspect mine operations, compel compliance with conditions of the permit, and order the mine drainage stopped when a clear and present danger to public health exists. And, finally, injunctive relief is available for violations of the Act.[28]

Aside from the pollution problems of mining operations, the industrial use of coal often results in water pollution contrary to source-based effluent limitations. An example of the problem is the effluent limitations for Raw Steelmaking Operations.[29] Among the limitations are those to process waste water discharges from the coke making operations conducted by the heating of coal in slot type ovens in the absence of air to produce coke. (By-product Coke) And, limitations applicable to process water discharges resulting from the coke making operations conducted by the heating of coal with the admission of air in controlled amounts for the purpose of producing coke (Beehive Coke).[30] Among the liquid waste from by-product coke is excess ammonia liquor resulting from the condensation of moisture originally present in the raw coal before coking.[31] The pollutants are similar in beehive waste waters but are much lower since the volatile components are allowed to escape to the atmosphere.[32] Accordingly, effluent limitations which reflect the application of the best technology available have been established. These limitations must be met or the industry is in violation of the FWPCA.

From the above example, the effect of the FWPCA on the coal industry can be seen. Whenever the mining or use of coal in industry causes water pollution, the requirements of the appropriate water quality standards or effluent limitations must be met.

FOOTNOTES

1. Joelsen and Fleischaker, "The Water Pollution Control Act," 20-2 The Practical Lawyer, 29 at 30, 1974
2. Ibid, at 29.
3. Ibid, at 31.
4. Ibid.
5. "Point source" is defined as any installation or conduit from which pollutants may be discharged.
6. Supra, note 1 at 32.
7. 1 Pollution Control Guide (Commerce Clearing House Topical Law Reports) 601, 1975.
8. Ibid.
9. 1 Commerce Clearing House Pollution Control Guide 551.
10. Those water quality standards that have been approved by EPA appear at ¶8800 of the Commerce Clearing House Pollution Control Guide.
11. 1 Commerce Clearing House Pollution Control Guide 575.
12. Ibid, at 579.
13. Supra, note 1 at 37.
14. Charles W. Smith, "Highlights of the Federal Water Pollution Control Act of 1972," 77 Dickinson Law Review 477, 1973.
15. Ibid, at 478.
16. Ibid, at 479.
17. Ibid, at 483.
18. Supra, note 1 at 39.
19. Supra, note 14 at 483-85.

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20. Mine drainage is surface or ground water which flows from a surface or underground mine or mining site. Acid formation occurs when pyrite and marcasite--sulfur bearing materials associated with a coal--are exposed to oxygen and water. A series of reactions occurs producing concentrations of acids sulfates, etc.

21. "Environmental Law - Acid Mine Drainage," 76 *West Virginia Law Review* 508, 1974.

22. *Ibid*, at 516 N 45.

23. West Virginia Code Annal, § 20-5A-1 to 16, 1973.

24. *Ibid*, § 2 (f), (h).

25. *Ibid*, § 5 (a)(6).

26. *Supra*, note 21 at 517.

27. *Ibid*.

28. *Ibid*.

29. 1 Commerce Clearing House Pollution Control Guide 1053.

30. *Ibid*.

31. *Ibid*, at 1057.

32. *Ibid*, at 1059.